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Selective laser melting of a high-strength aluminium alloy

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Is it possible to process EN AW 7075 using SLM with high quality?

Additive manufacturing (AM) of highly complex metal structures using selective laser melting (SLM) is increasingly gaining interest. In the aerospace industry, metal alloys with a high strength to weight ratio play an important role. Although several Ti- and Al-alloys have been SLM-processed successfully, the high-strength aluminium alloy EN AW 7075 remains a challenge. The high sensitivity to hot cracks caused by process related temperature gradients and rapid solidification represents the major challenge. Preheating is a promising approach to reduce temperature gradients and minimize shrinking between the layers.

Methods and Results

Single track parameter study

- Identification of promising laser parameters

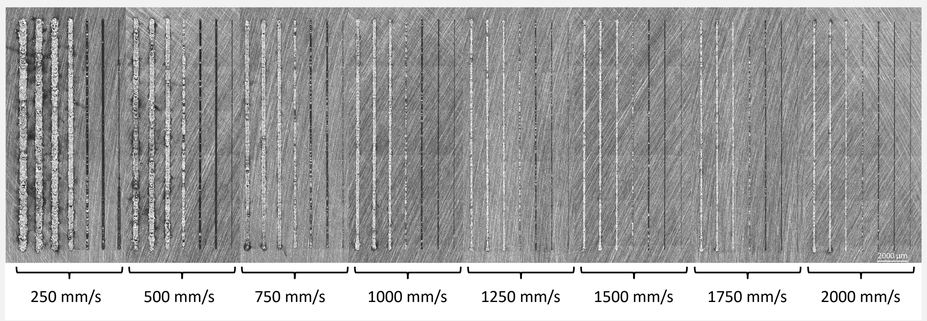

Fig. 1: Single track parameter study: Scan velocity vs. Laser power
Laser power (from left to right): 100, 150, 200, 250, 300, 350 and 400 W

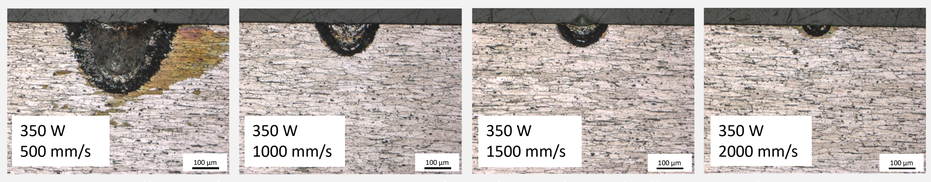

Fig. 2: Metallographic cross-sectioning of single tracks on bulk material at 350 W laser power and scan velocity of 250-2000 mm/s.

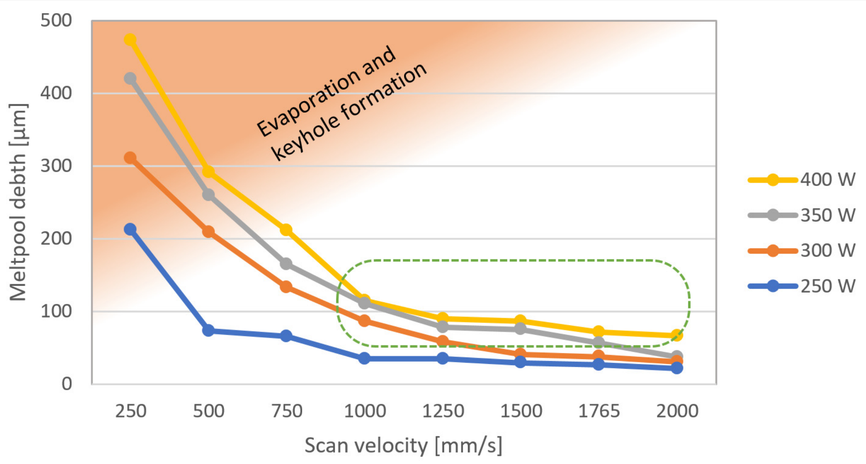

Fig. 3: Meltpool depth in relation to scan velocity at 250-400 W laser power.

Multi-layer parameter study

- Refinement of laser parameters for 3D structures
- Effects of parameters and preheating on cracking

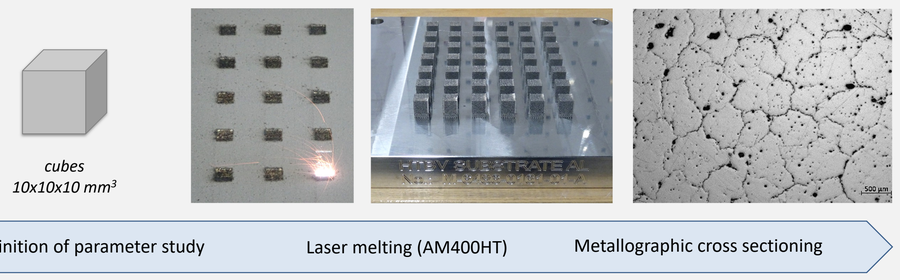

Fig. 4: Schematic representation of the methodology.

Parameters
- Laser Power: 350 W
- Hatching: 50 µm
- Scan vel.: 1000 mm/s
- Layers: 40 µm
- Baseplate temp: 350 °C

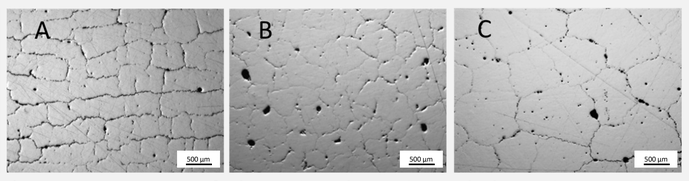

Fig. 5: Effect of the baseplate temperature of A) 100 °C, B) 250 °C and C) 350 °C on crack formation.

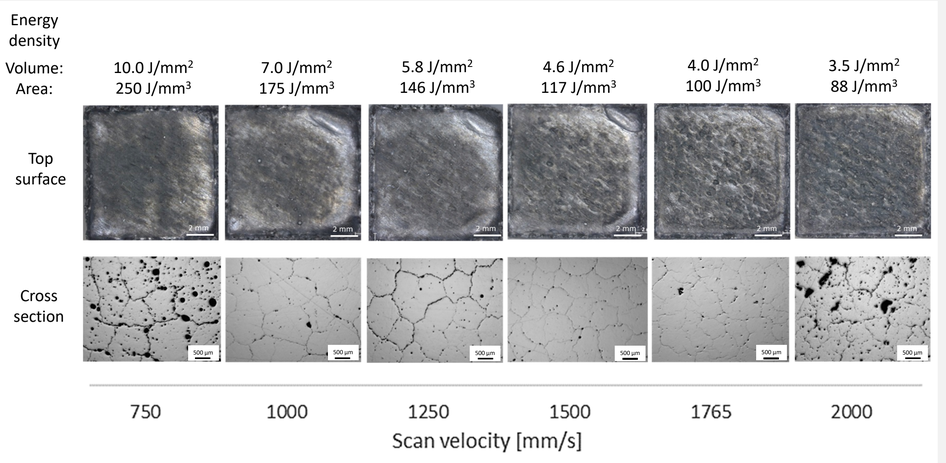

Fig. 6: Effects of energy density and scan velocity on cracking and porosity.
Parameters: Power 350 W, Baseplate temp. 350 °C, hatching 50 µm, Layer 40 µm.

Conclusion and further work

- SLM Processing of EN AW 7075 with low porosity (0.6 %) possible
- Preheating of the baseplate up to 350 °C reduces cracking, but doesn't avoid it completely
- Further work: Effects of layer thickness and powder material, slight modifications of the alloy to reduce cracking

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